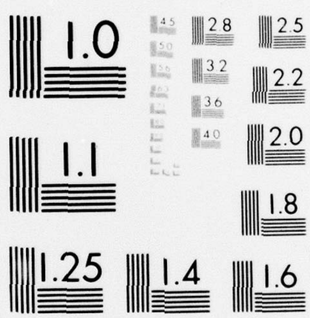
AD-A037 422 COLD REGIONS RESEARCH AND ENGINEERING LAB HANOVER N H F/G 13/2
CHEMICAL COMPOSITION OF SNOW ON THE WATER SURFACE OF THE KAMA A--ETC(U)
MAR 77 N A PECHERKIN, E A BURMATOVA

UNCLASSIFIED CRREL-TL-611 NL

| OF |
ADA037422

END
DATE
FILMED
4-77



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Draft Translation 611
March 1977

12

CHEMICAL COMPOSITION OF SNOW ON THE WATER SURFACE OF THE KAMA AND VOTKINSK RESERVOIRS

N.A. Pecherkin and E.A. Burmatova

CORPS OF ENGINEERS, U.S. ARMY
COLD REGIONS RESEARCH AND ENGINEERING LABORATORY
HANOVER, NEW HAMPSHIRE

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER

Draft Translation 611

2. GOVT ACCESSION NO.

3. RECIPIENT'S CATALOG NUMBER

4. TITLE (and Subtitle)

CHEMICAL COMPOSITION OF SNOW ON THE WATER SURFACE OF THE KAMA AND VOTKINST RESERVOIRS

5. TYPE OF REPORT & PERIOD COVERED

6. PERFORMING ORG. REPORT NUMBER

7. AUTHOR(s)

N.A. Pecherkin and E.A. Burmatova

8. CONTRACT OR GRANT NUMBER(s)

9. PERFORMING ORGANIZATION NAME AND ADDRESS

U.S. Army Cold Regions Research and Engineering Laboratory
Hanover, New Hampshire

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS

11. CONTROLLING OFFICE NAME AND ADDRESS

12. REPORT DATE

March 1977

13. NUMBER OF PAGES

7

14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)

15. SECURITY CLASS. (of this report)

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

SNOW--CHEMICAL ANALYSIS
WATER QUALITY
DAMS

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This article reports findings from an investigation of snow on the water surface of the Kama and Votkinsk reservoir conducted in the winter of 1961-63. The chemical composition of the sample was determined by the technique of Ye. S. Burkser, N.Ye. Fedorova and B.B. Zaydis. Observations made on these reservoirs made possible a rough calculation of the amount of salt arriving on the water surface.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)

SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)

(14) CRREL-TL-611

DRAFT TRANSLATION 611

(6)

ENGLISH TITLE: CHEMICAL COMPOSITION OF SNOW ON THE WATER SURFACE OF THE KAMA AND VOTKINST RESERVOIRS

FOREIGN TITLE: (KHMICHESKII SOSTAV SNEGA NA AKVATORII KAMSKOGO I VOTKINSKOGO VODOKHRANILISH),

(10)

AUTHOR: N.A. Pecherkin ~~and~~ E.A. Burmatova (USSR)

(21) Trans. of

SOURCE: Novocherkassk, Gidrokhimicheskiye materialy, ~~vol.~~ v39, ~~1965~~, 7p. 1965

Translated by U.S. Joint Publications Research Service for U.S. Army Cold Regions Research and Engineering Laboratory, 1977, 7p.

(11) Mar 77

(12) 11p.

ACCESSION for

NTIS

A

NOTICE

037100

JB

CHEMICAL COMPOSITION OF SNOW ON THE WATER SURFACE OF THE KAMA AND VOTKINSK RESERVOIRS

Novocherkassk GIDROKHIMICHESKIYE MATERIALY in Russian Vol 39 1965 pp 1-7

[Article by N. A. Pecherkin and E. A. Burmatova, Perm' State University imeni A. M. Gor'kiy, Laboratory for Water Management Problems]

[Text] Investigating the chemical composition of atmospheric precipitation is part of aerohydrochemical geography, a discipline that is still poorly covered in Permskaya Oblast. The first work in this discipline was done by Professor G. A. Maksimovich in 1945 [1]. Sample analysis showed that the mineralization of precipitation depends on the site of precipitation, increase in the mineralization of snow with the time the snow is on the surface and the effect of residential and industrial atmospheric pollution on the chemical composition of snow. A fuller study of the chemical composition of snow was done by Maksimovich in 1947 and 1954. From these data, snow mineralization varies in the range of 56-150 mg/liter [2]. Moreover, in 1955-1958 an analysis was made of sample of rainwater and snow collected on the university grounds in the city of Perm', near the hamlet of Froly, the village of Chastyye and the village of Ust'-Kishert' [3].

This article reports findings from an investigation of snow on the water surface of the Kama and Votkinsk reservoir, conducted by the authors in the winter of 1961-1963. The chemical composition of the sample was determined by the technique of Ye. S. Burkser, N. Ye. Fedorova and B. B. Zaydis [4].

As we know, the chemical composition and degree of mineralization of atmospheric precipitation depend on a complex of physicogeographic factors. A key role is played by the time of the year and the nature and amount of precipitation. The preceding weather and wind direction, along with industrial air pollution are very important. Mineralization of rainwater and snow water varies with time. After long dry spells, this mineralization reaches a maximum and after the next precipitation, it diminishes [3,5-11].

Some of these principles are closely corroborated by our investigations. To illustrate: near the city of Okhansk daily snowfalls were observed in January 1962. So snow samples gathered on 23 Jan showed slight mineralization--

12.4-18.5 mg/liter; the content of hydrocarbonate ions was 6.1 mg/liter, sulfate ions--3.0-4.0 mg/liter, Na· + K·--1.9-4.1 mg/liter and $NH_4^{\cdot}$--1.4-1.5 mg/liter. Snow samples collected at the end of January were free of chloride, nitrite and nitrate ions, and calcium and magnesium ions--the result of the purifying action of snow on air (Table 1).

Table 1. Chemical Composition of Snow on the Water Surface of the Votkinsk Reservoir on the Left Bank near the City of Okhansk (Winter of 1961-1962), mg/liter

(1) Снег	pH	HCO_3'	SO_4''	Cl′	NO_3'	NO_2'	Ca··	Mg··	Na·+K·	$NH_4^{\cdot}$	$\Sigma_и$	Гидрохимическая фация (2)
(3) Свежевыпавший	5.5	6.1	3.0	(4) нет	(4) нет	(4) нет	(4) нет	(4) нет	1.9	1.40	12.4	HCO_3—SO_4—Na
(5) Лежалый . . .	6.4	4.9	4.0	6.8	нет	нет	4.4	0.7	1.7	нет	22.5	Cl—HCO_3—Ca
(6) Старый	5.4	12.2	4.0	10.6	3.4	0.15	4.0	нет (4)	9.6	0.40	44.4	HCO_3—Cl—Na

Key:

1. Snow
2. Hydrochemical facies
3. Newly fallen
4. none
5. Long-lain
6. Old

Observations showed that freshly fallen snow in the Votkinsk Reservoir zone ($\Sigma_и$ = 12.0-18.0 mg/liter) is much "cleaner" than fresh snow fallen on Perm' ($\Sigma_и$ = 104-130 mg/liter) [2]. With time, the structure of the snow on the water surface of the reservoir changes. Snow becomes more compact and its specific weight increases. Also changing is the chemical composition of the snow water; its mineralization increases to 20-22 mg/liter (Table 1). In the February samples of long-lain snow (city of Okhansk) were found chloride ions (6.7 mg/liter), calcium ions (2.4-4.4 mg/liter) and magnesium ions (0.4-0.7 mg/liter); there was more sulfate ion (4-8 mg/liter) and less Na˙ + K˙ (1.6--3.6 mg/liter); ammonia ions disappeared. Long-lain snow later passed into the stage of old, firnified snow [12]. The snow cover gradually compacted and its mineralization decreased from 44.4-48.9 mg/liter; the pH of the snow water was reduced from 6.4-6.3 to 5.7-5.4. In the chemical composition of old snow the content of hydrocarbonate ions doubled compared with newly fallen snow. The content of chlorides and sodium increased; NO_2' and NO_3' ions appeared--a consequence of local pollution. Thus, with time the chemical composition of snow did not remain constant.

The geographic location and the geological conditions of the microregion in which the samples were collected are very important in the hydrochemical survey of snow. For example, near the Chusovskiy bay of the Kama Reservoir, high steep banks are made of gypsum and anhydrites. In their outcroppings, owing to the weathering, rocks broke up and settled as dust on the snow cover.

The result was that snow was enriched with sulfates and carbonates of calcium and magnesium. For example, the mineralization of snow in the Kulikovo-Zaozer'ye open pit changed over wide limits (Table 2). Most mineralized was the snow sample collected 100 m from outcroppings of gypsum and anhydrite on the right bank near the hamlet of Kulikovo-Zaozer'ye (84.7 mg/liter). In a direction toward the left bank formed of alluvial deposits [13], mineralization of snow gradually decreased, reaching 24.1 mg/liter. Likewise, the sulfate content in the left bank fell by 17 times--from 32.7 to 1.9 mg/liter. There were no calcium and magnesium ions here. The absence of nitrites and nitrates was typical of all samples in the open pit. The maximum content of SO_4'' ions in the composition of the snow was noted also near the right bank of the Chusovskiy pool near the village of Syola (37.0 mg/liter), 43 percent of the total snow mineralization. Chloride, nitrate and nitrite pollution of snow is absent here. Thus, the sulfates in snow on the water surface of the Chusovskiy pool was caused by weathering of rock making up the reservoir bank.

Table 2. Chemical Composition and Mineralization of Snow on the Water Surface of the Kama Reservoir, Kulikovo-Zaozer'ye Open Pit, on 23 Dec 61, mg/liter

(1) Место отбора проб	(2) В 150 м от левого берега	(3) В 500 м от левого берега	(4) В 500 м от правого берега	(5) В 150 м от правого берега
(6) Общая минерализация, мг/л . .	24,1	29,9	55,4	84,7
(7) Гидрохимическая фация [1] . . .	HCO_3—Na—Cl	HCO_3—Na—SO_4	HCO_3—SO_4—Na	SO_4—HCO_3—Na

Key:
1. Sampling site
2. 150 m from left bank
3. 500 m from left bank
4. 500 m from right bank
5. 150 m from right bank
6. Total mineralization, mg/liter
7. Hydrochemical facies [1]

The high SO_4'' concentration in the vicinity of large population centers and industrial sites was caused by human activity. The higher content of sulfates (12.00-29.40 mg/liter) was observed in the cities of Solikamsk, Chermoz, Polazna, Perm' and others (Table 3). Here the sources of SO_4'' ions entering the atmosphere are mainly industrial gases (SO_2) formed during the combustion of coal. Atmospheric pollution also occurs during the deflation of weathering products of solid wastes of the ore recovery industry collected in tailing dumps and waste piles. The result is that air becomes considerably enriched with Cl', $Na^{\cdot}$ and $K^{\cdot}$ ions. Intensive pollution with chlorides, sodium and potassium was noted also in the microrayon of the Solikamsk Potassium Combine. For a 304 mg/liter mineralization of snow, the Cl' ion content was 178.8 mg/liter (58.8 percent of total mineralization) and the concentration of sodium

and potassium was 84.7 mg/liter (24.5 percent). Least mineralized was snow in the central part of the Kama Reservoir. Snow mineralization was only 5.5 mg/liter in the middle of the Visim-Chermoz profile, where the reservoir was 10-11 km wide and no industrial enterprises were nearby.

By the combustion of natural gas and gaseous petroleum products, snow near the city of Polazna contained 5.5 mg $NH_4^{\cdot}$/liter and 1.7 mg $NO_2^{'}$/liter, with a mineralization of 51 mg/liter. However, 45 km west of the city of Polazna the mineralization of snow was halved. Snow collected in several inhabited localities and near the roads was marked by significant nitrate and residential pollution (city of Chermoz, hamlet of Belyayevka and vicinity of Popovka River).

Snow on the water surface of the Votkinsk Reservoir contains less salt that the Kama Reservoir, owing to the Votinsk Reservoir's greater distance from large industrial sites.

From these data we see that snow mineralization on the territory studied varied from 5.5 to 304 mg per liter of snow water. The average value of total snow mineralization, calculated from the data in Table 3, is about 47 mg/liter; this coincides with the mean mineralization for the USSR--46.42 mg/liter, according to G. A. Maksimovich [2].

Observations made during 1961-1962 on the Kama and Votkinsk reservoirs made possible a rough calculation of the amount of salts arriving on their water surface. The reservoirs were divided into characteristic regions, for which the arithmetic mean amounts of solid deposits and precipitating salts were found. As a result, from November to March 13,000 tons of various salts fell on the area of the Kama Reservoir (1735 km^2) and about 7000 tons on the water surface of the Votkinsk Reservoir (reservoir area 1120 km^2). During this same period 45,000 tons of salt fell within the city of Solikamsk.

Conclusions

1. Significant inhomogeneity of the chemical composition of snow was found in the vicinity of the Kama and Votkinsk reservoirs. For example, minimum snow mineralization (5.5 mg/liter) was observed in the central part of the water surface of the Kama Reservoir, at a point furthest removed from industrial enterprises; maximum mineralization (304 mg/liter) was recorded in the city of Solikamsk near the potassium combine.

2. The presence in snow samples collected on the territory surveyed of the ions Cl', $Na^{\cdot} + K^{\cdot}$, $NH_4^{\cdot}$, $NO_2^{'}$, $NO_3^{'}$ and $SO_4^{''}$ is significantly linked to human activity. In some cases increased $SO_4^{''}$ content can be associated with the geological structure of the banks.

3. The chemical composition of snow varied with time in the same sampling site.

Table 3. Analysis of Snow Samples Collected in 1962 on the Water Surface of the Kama and Votkinsk Reservoirs, mg/liter

(1) № п/п	(2) Место отбора	(3) Дата	HCO_3'	SO_4''	Cl'	NO_3'	NO_2'	Ca··	Mg··	Na·+K·	$NH_4^·$	$\Sigma_и$	pH	Окисляемость, мг O/л (4)	(5) Гидрохимическая фация
	I. Район Камского водохранилища (6)														
1	Северо-восточная окраина (7) г. Соликамска	20/II	18,3	29,4	7,1	нет (16)	нет (16)	12,0	1,2	6,9	2,0	77,0	6,4	3,30	SO_4—HCO_3—Ca
2	Соликамский калийный комбинат (8)	20/II	нет (16)	14,0	178,8	нет (16)	нет (16)	12,7	9,3	84,7	4,5	304,0	4,7	7,20	Cl—Na—SO_4
3	80 м от правого берега Камы, выше устья р. Поповки (9)	20/II	6,8	12,0	5,3	14,5	нет (16)	8,1	1,0	4,6	1,2	53,5	6,1	2,5	NO_3—SO_4—Ca
(10) 4	200 м от левого берега, на разрезе Висим — Чермоз	11/II	нет (16)	2,0	3,5	нет (16)	нет (16)	2,4	0,1	0,10	0,10	8,2	5,3	3,7	Cl—Ca—SO_4
(11) 5	4 км от левого берега, на разрезе Висим — Чермоз	10/II	нет (16)	2,0	1,7	нет (16)	нет (16)	нет (16)	нет (16)	0,6	1,2	5,5	6,2	2,7	SO_4—Cl—NH_4
6	Район г. Чермоза (12)	10/II	6,3	12,0	1,1	28,9	0,7	1,3	0,1	10,7	6,0	67,1	6,5	5,1	NO_3—SO_4—Na
7	Район г. Полазны (13)	12/II	10,2	14,0	7,1	нет	1,7	3,1	4,9	4,5	5,5	51,0	6,7	5,8	SO_4—HCO_3—Cl
8	400 м от правого берега, напротив г. Полазны (14)	12/II	3,2	8,0	5,1	нет (16)	нет (16)	1,9	0,10	6,0	нет (16)	24,3	5,5	4,1	SO_4—Na—Cl
9	У правого берега Камы, район г. Оханска (15)	22/II	1,2	8,0	4,2	нет (16)	нет (16)	2,4	0,4	3,6	нет (16)	19,8	6,2	1,3	SO_4—Cl—Na
	II. Район Воткинского водохранилища (17)														
10	(18) 100 м от левого берега, напротив фанерного комбината	15/III	7,1	14,0	4,8	нет (16)	0,03	7,1	0,5	0,5	2,10	36,1	5,6	4,2	SO_4—Ca—HCO_3
11	75 м от левого берега, у с. Ново-Ильинского (19)	14/III	6,6	2,0	6,2	нет (16)	0,15	1,6	0,2	5,2	нет (16)	22,0	6,2	—	HCO_3—Cl—Na
12	50 м от правого берега, у д. Казанки (20)	12/III	5,1	16,0	4,1	нет (16)	0,03	нет (16)	нет (16)	10,1	1,7	37,0	5,5	5,7	SO_4—Na—HCO_3
13	100 м от правого берега, у д. Беляевки (21)	13/III	6,1	нет (16)	42,2	14,1	0,02	нет (16)	нет (16)	9,2	2,1	73,7	5,6	3,1	Cl—NO_3—Na

Key [on following page]

Key [to Table 3 on preceding page]:

1. Number
2. Sampling site
3. Date
4. Oxidizability, mg O/liter
5. Hydrochemical facies
6. Vicinity of Kama Reservoir
7. Northeast outskirts of the city of Solikamsk
8. Solikamsk Potassium Combine
9. 80 m from the right bank of the Kama River, near the mouth of the Popovka River
10. 200 m from the left bank, on the Visim-Chermoz profile
11. 4 km from the left bank, along the Visim-Chermoz profile
12. Vicinity of city of Chermoz
13. Vicinity of city of Polazna
14. 400 m from the right bank, opposite the city of Polazna
15. Right bank of the Kama River; vicinity of the city of Okhansk
16. none
17. Vicinity of Votkinsk Reservoir
18. 100 m from the left bank, opposite the plywood combine
19. 75 m from the left bank, near the village of Novo-Il'inskiy
20. 50 m from the right bank, near the hamlet of Kazanka
21. 100 m from the right bank, near the hamlet of Belyayevka

4. In the winter period (September-March) 13,000 tons of salt fell on the water surface of the Kama Reservoir, that is, 7.46 tons per km^2. In the city of Solikamsk, 45 tons of salt was deposited on 1 km^2, of which Cl' and $Na^{\cdot} + K^{\cdot}$ accounted for 37 tons.

Received
12 March 1963

BIBLIOGRAPHY

1. Maksimovich, G. A., "Hydrochemical Facies of the Water of Lakes (and Seas)," DAN SSSR, Vol 47, No 8, 1945, pp 582-585.

2. Maksimovich, G. A., "Chemical Composition of Atmospheric Precipitation in the City of Perm' and Combatting Atmospheric Pollution," Paper given at the Fifth All-Urals Conference on Problems of Geography and Conservation of the Natural Resources of the Urals, Perm', 1959.

3. Maksimovich, G. A., "Chemical Composition of Atmospheric Precipitation of the City of Perm' and Combatting Atmospheric Pollution," "Okhrana prirody na Urale" [Conservation of Natural Resources of the Urals], No 2, 1961, Perm'.

4. Burkser, Ye. S., Fedorova, N. Ye., and Zaidis, B. B., "Atmospheric Precipitation and Its Role in the Migration of Chemical Elements Through the Atmosphere," TR. KIYEVSKOY GMO, No 2, 1952.

5. Kolodyazhnaya, A. A., "Atmospheric Precipitation as a Source for the Arrival of Water-Soluble Salts on Land," TR. LABORATORII GIDROGEOL. PROBLEM AN SSSR, Vol 36, 1961, pp 58-64.

6. Maksimovich, G. A., "Role of Atmospheric Precipitation in the Transport of Soluble Compounds," DAN SSSR, Vol 92, 1953, pp 401-403.

7. Grabovskiy, R. I., "World Ocean as a Source of Atmospheric Condensation Nuclei," IZV. AN SSSR, SER. GEOGR., No 2, 1952.

8. Dobroklonskiy, S. V., and Vavilov, P. V., "Problem of Loss of Salts to Land with Sea Water Splashes," IZV. AN SSSR, No 1, 1938.

9. Blinov, L. K., "Arrival of Marine Salts in the Atmosphere and the Significance of the Wind in the Salt Balance of the Caspian Sea," TR. GOIN, No 15(20), 1950, pp 67-113.

10. Tomson, N. M., "Pollution and Purification of the Air from Products of Incomplete Fuel Combustion," PRIRODA, No 5, 1955, pp 86-88.

11. Grabovskiy, R. I., "Concentration of Chlorides in Precipitation and Cloud Elements," VESTNIK LENINGR. UN-TA, No 10, 1951.

12. Chebotarev, A. I., "Obshchaya gidrologiya" [General Hydrology], Gidrometeoizdat, Leningrad, 1960.

13. Pecherkin, I. A., "Banks of the Kama Reservoir," Paper given at the Fourth All-Urals Conference on Physicogeographical and Economic-Geographic Regionalization, Perm', 1958.